Latest jet results from the Tevatron

Moriond QCD

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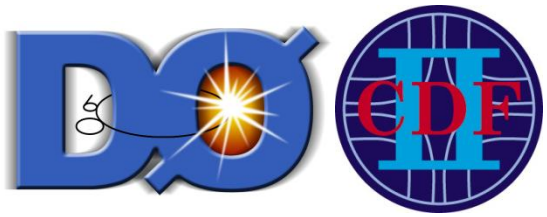
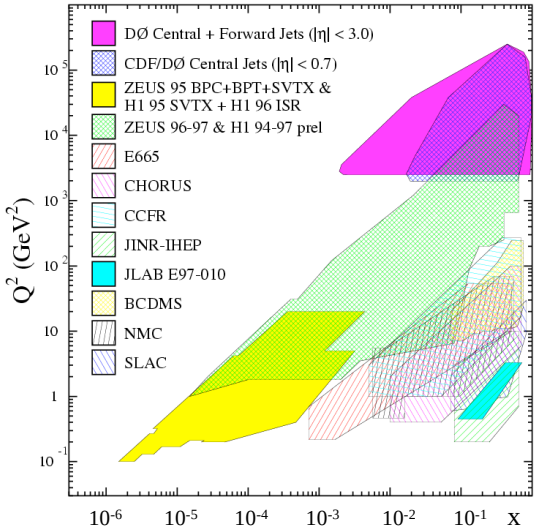
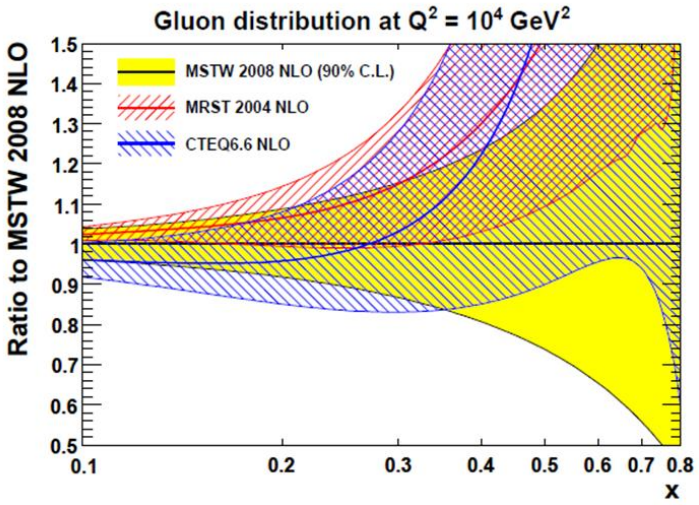
on behalf of the CDF and DØ collaborations



Inclusive jet measurements from Tevatron constrain gluon PDF

- Low x: from DIS data, PDFs well constrained here
- High x, high Q^2: only direct constraints can come from Tevatron inclusive jet measurements
- Impact on other Tevatron/LHC physics
  - New Phenomena searches limited without understanding QCD
  - Higgs production cross-section modified by lower gluon densities at high x





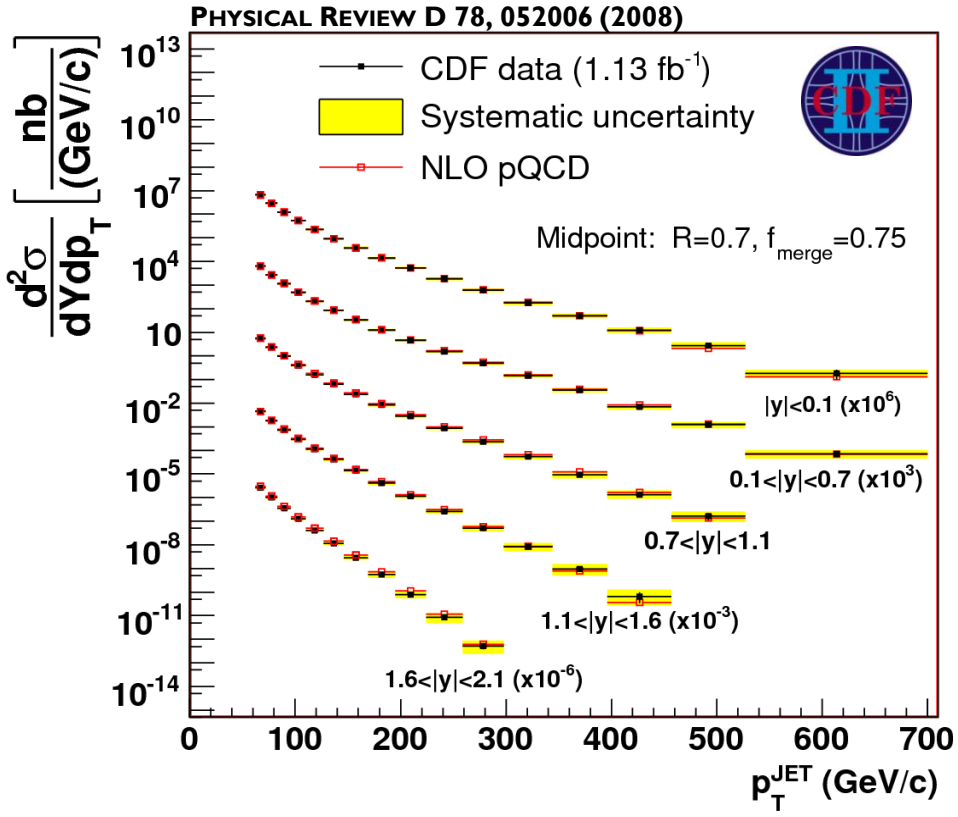
Tests of NLO pQCD calculations at high Q^2, MC generators, jet algorithms

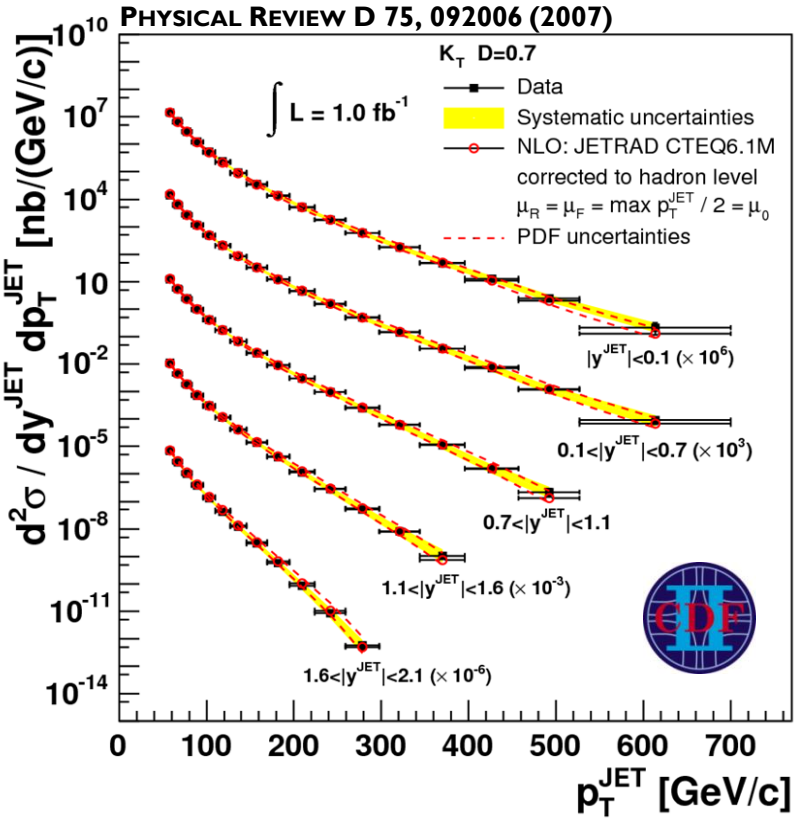
- Inclusion of non-perturbative corrections
- p_T and rapidity ranges extended in RunII
- Comparisons of k_T and cone jet algorithms

Sensitivity to new physics

Inclusive jet production

Midpoint/k_T algorithm





Inclusive jet measurements test pQCD over 8 orders of magnitude and up to p_T^{jet}>600 GeV

CDF measured inclusive cross-section with k_T clustering algorithm (D=0.4, 0.7, 1.0) and Midpoint cone (R=0.7)

Data/theory consistent for cone and k_T with different distance parameters establishes that different algorithms can be used successfully at hadron colliders, with results in agreement

Inclusive jet production

Midpoint cone algorithm

DØ also measure inclusive jet cross-section using Midpoint cone

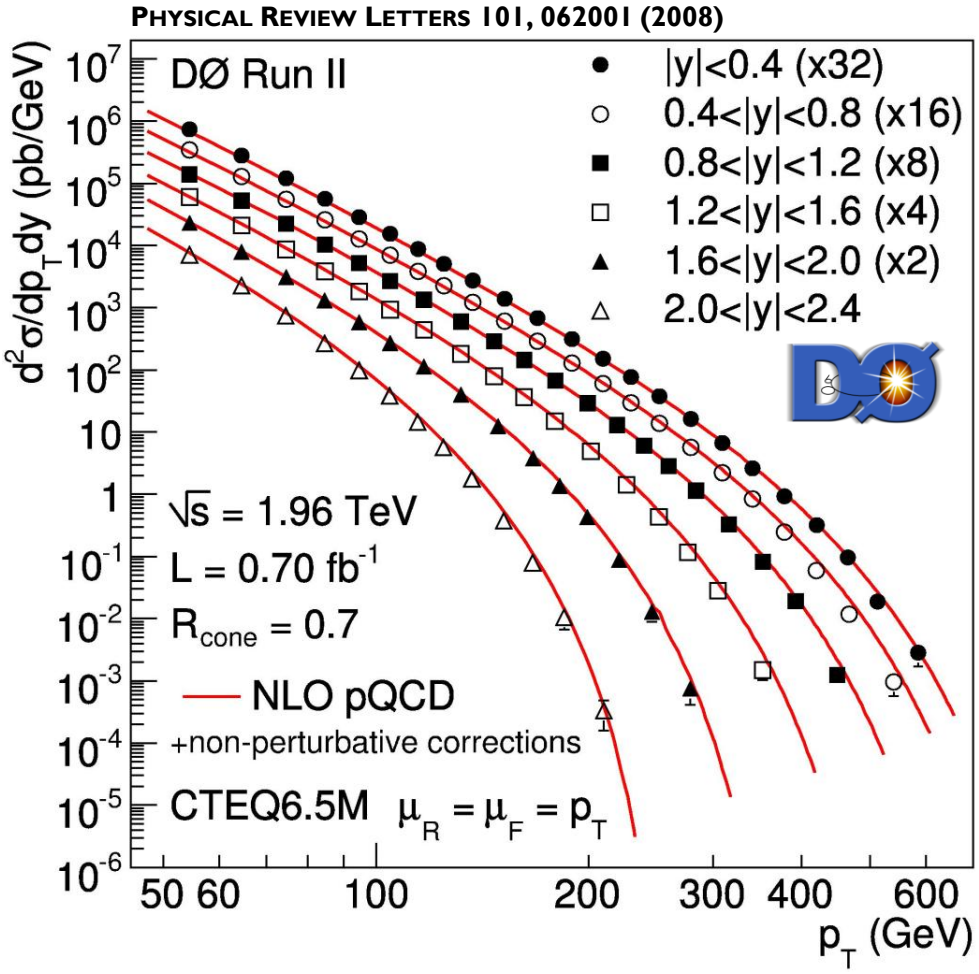
Dominant systematic jet energy scale

Spectrum steeply falling, so:
small JES uncertainty →
large error on cross-section!

JES uncertainty:
2-3% CDF, 1.2-2% DØ

Total uncertainty on cross-section:
15-50% CDF, 15-30% DØ

Other measurements in this talk build on understanding of jets/detector from inclusive measurement with this dataset



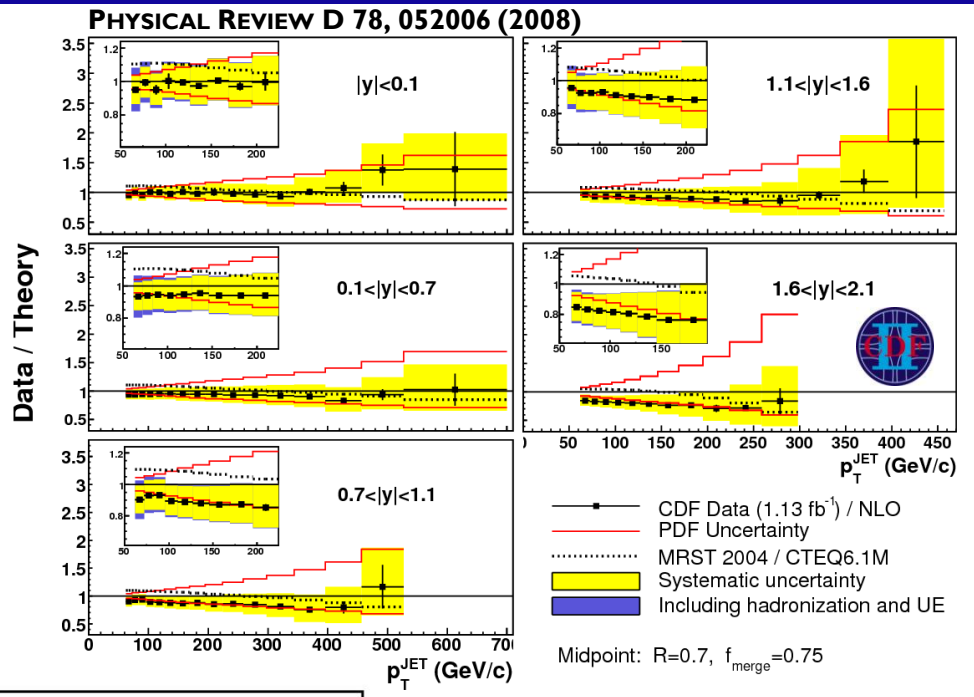
Inclusive jet production

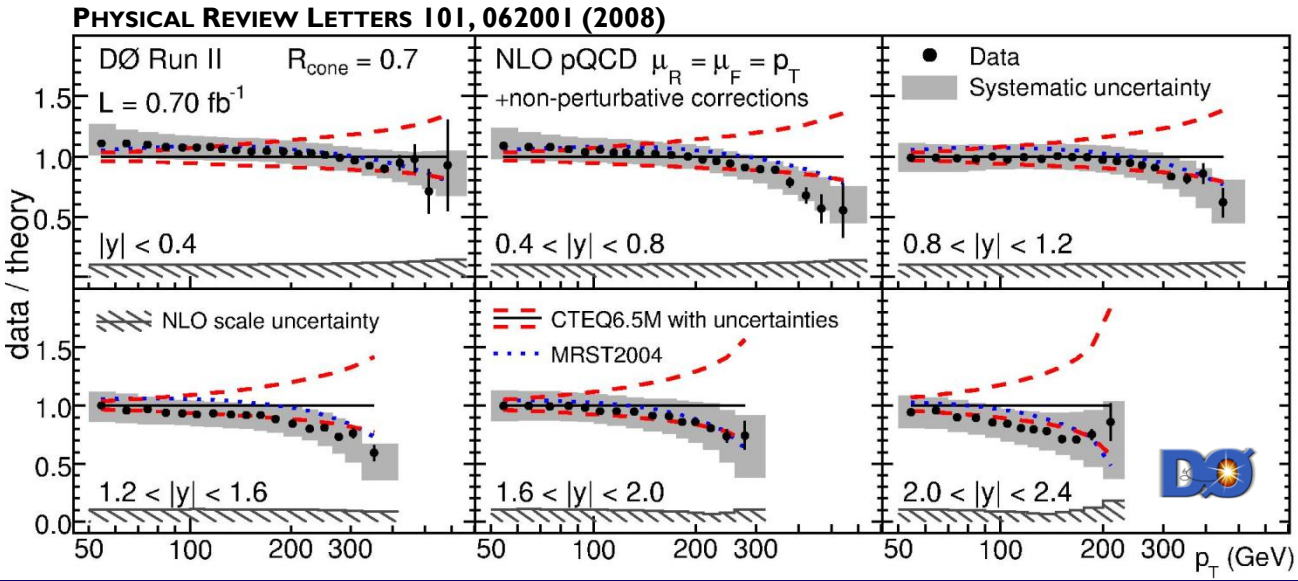
Comparison to theory

CDF and DØ measurements in agreement with NLO predictions

Data favours lower bound of theoretical prediction with smaller gluon content at high x

Experimental uncertainties lower than theoretical (largely PDF uncertainties): constrain PDFs



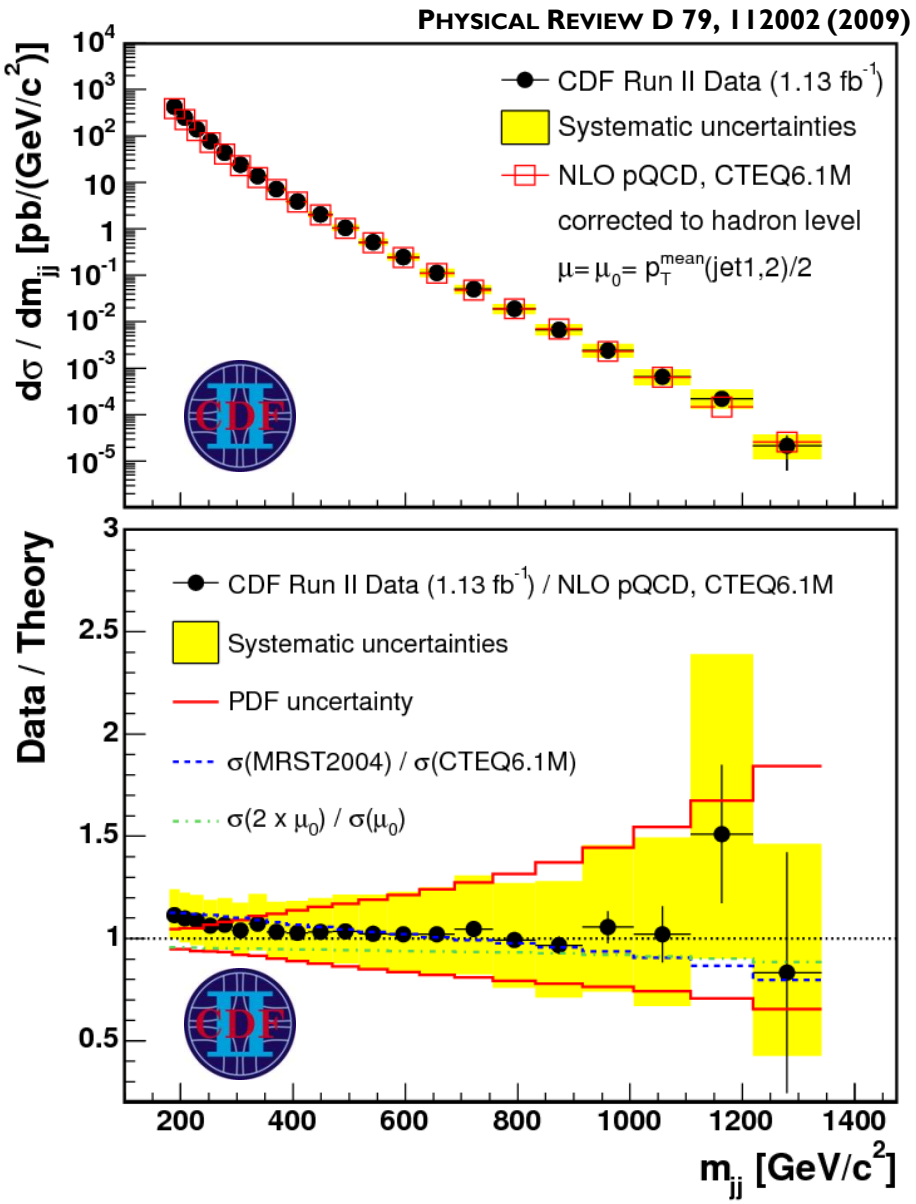


MSTW2008 uses CDF k_T and DØ cone results

Leads to reduced gluon PDF uncertainties

DØ most precise measurement to date

Dijet mass



Study dijet events in |y|<1.0

Uses same dataset as inclusive jets

New physics expected to be produced more centrally & expect better S/B in central region

Total uncertainty: $^{+13}_{-12}$% at low m_{jj}

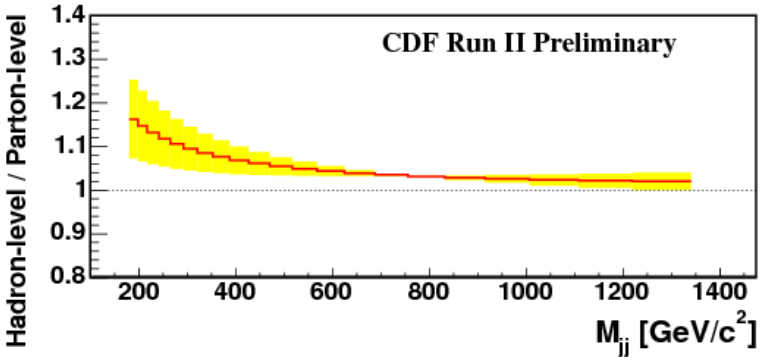
$^{+76}_{-49}$% at high m_{jj}

NLO pQCD +corr. to data: χ^2/ndf = 21/21

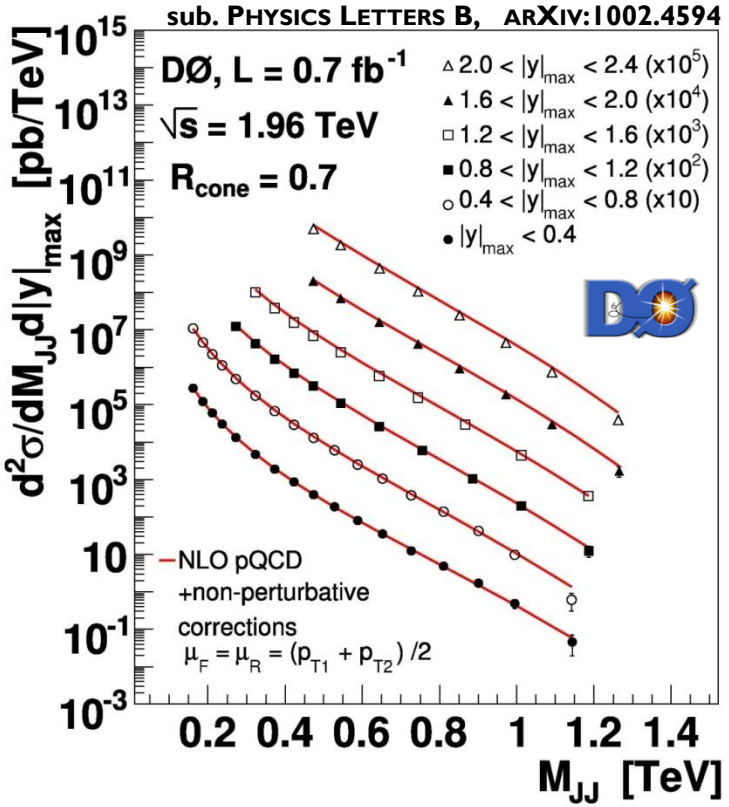
(syst. uncertainties and non-perturbative corrections all independent; fully correlated over m_{jj})

PARTON-TO-HADRON LEVEL CORRECTION

Pythia (TuneA) central value; Herwig PS taken as uncertainty



Dijet mass



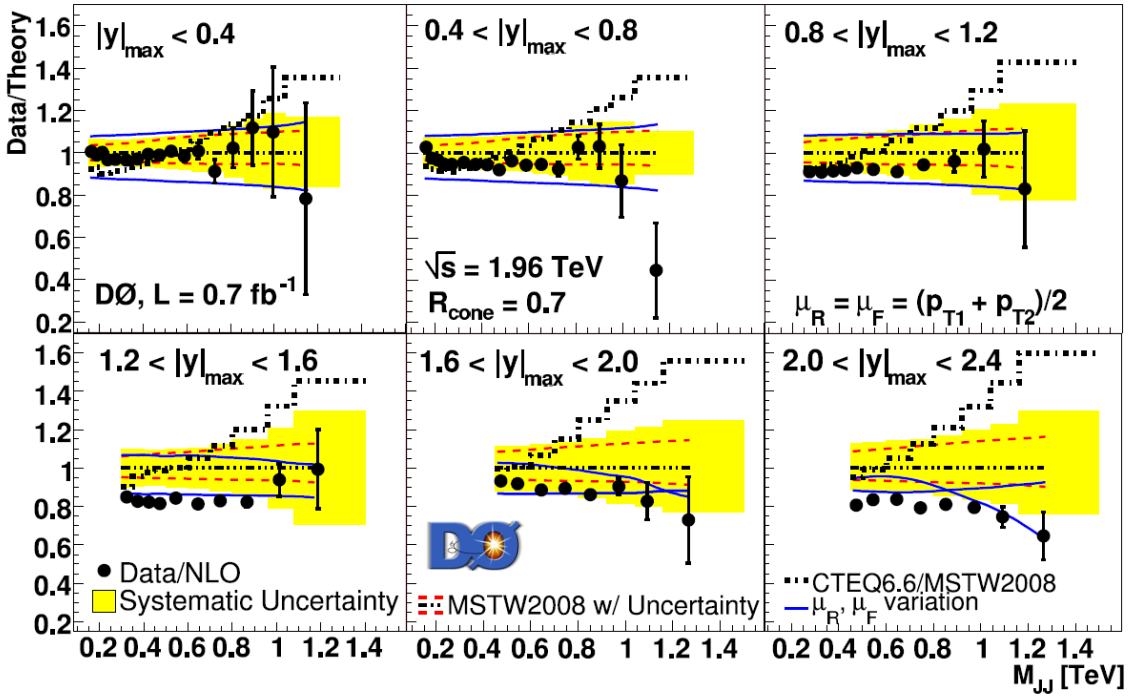
Data/QCD in good agreement in central region

40—60% difference between PDFs (MSTW2008/CTEQ6.6) at highest mass

Measurement of dijet mass in six rapidity bins ($|y|_{max}$ higher of the two jets)

Double-differential comparison to NLO pQCD with MSTW2008 NLO PDFs

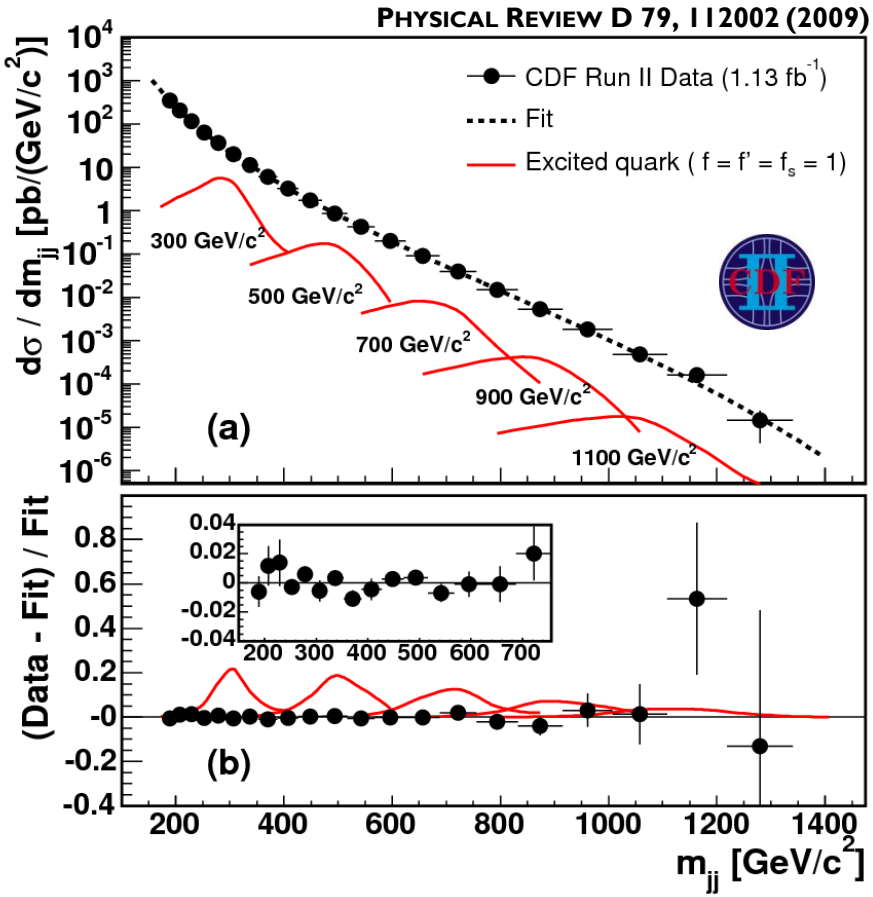
Non-perturbative corrections (-10%, 23%) depending on mass/rapidity bin

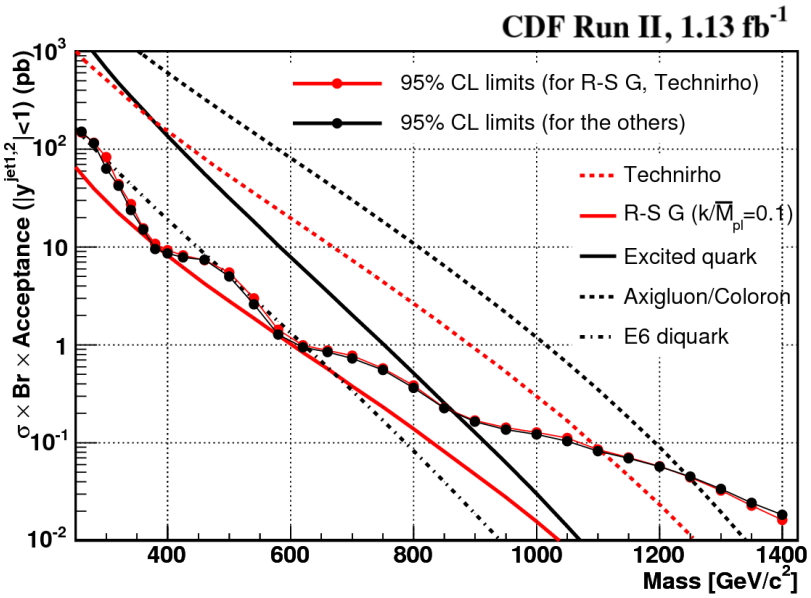


Dijet mass: searches

Dijet mass tests pQCD but also sensitive to presence of new physics via dijet resonances

Use uncorrected jet data to maximise sensitivity to resonance

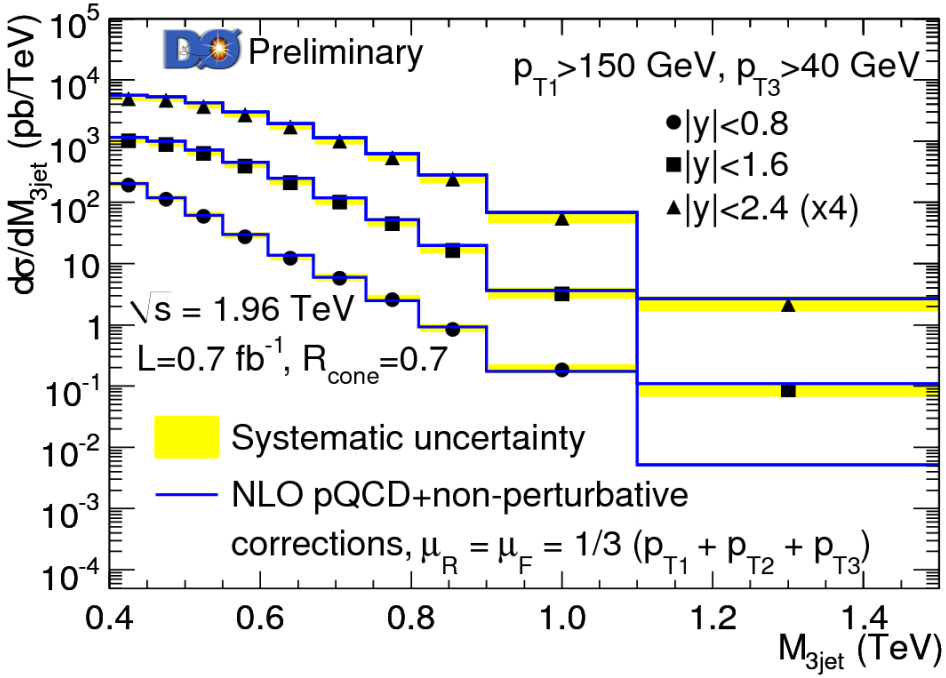




Observed mass exclusion range	Model description
260-870 GeV/c^2	Excited quark → qg (f=f'=f$_s$=1)
260-1100 GeV/c^2	ρ_{T8} techni-rho
260-1250 GeV/c^2	Axigluon/coloron
290-630 GeV/c^2	E$_6$ diquark
280-840 GeV/c^2	W' (SM couplings)
320-740 GeV/c^2	Z' (SM couplings)

No significant evidence for resonant structure has been observed, so set limits

Three-jet mass



Differential measurements of three-jet mass

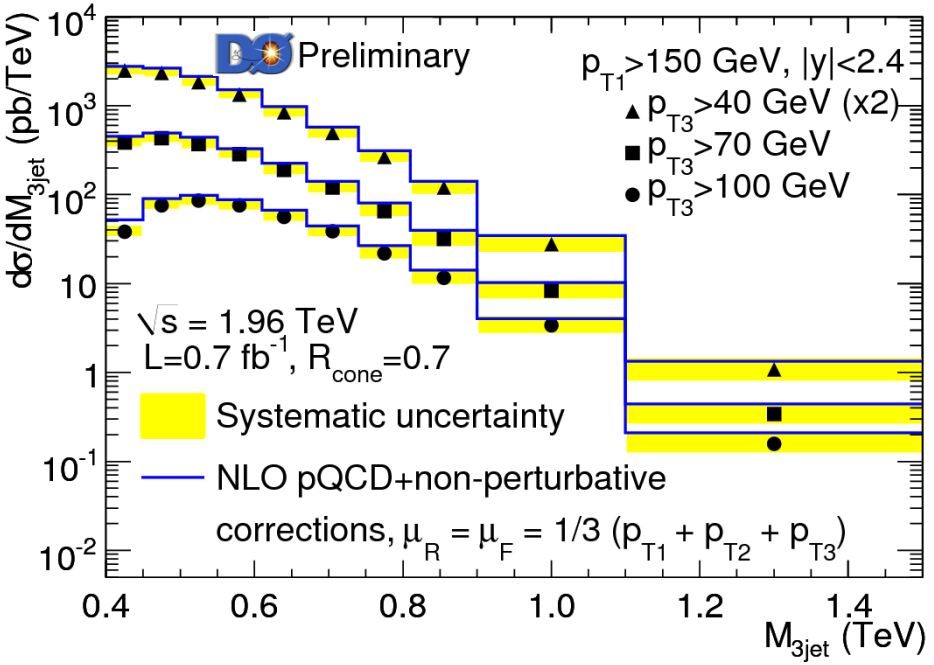
p_T^{lead}>150 GeV, p_T^{3rd} >40 GeV; ΔR_{jj}>1.4

Three-jet calculation available @NLO
Use NLOJET++ 4.1.2 with MSTW2008
NLO non-perturbative corrections (-3%,+6%)

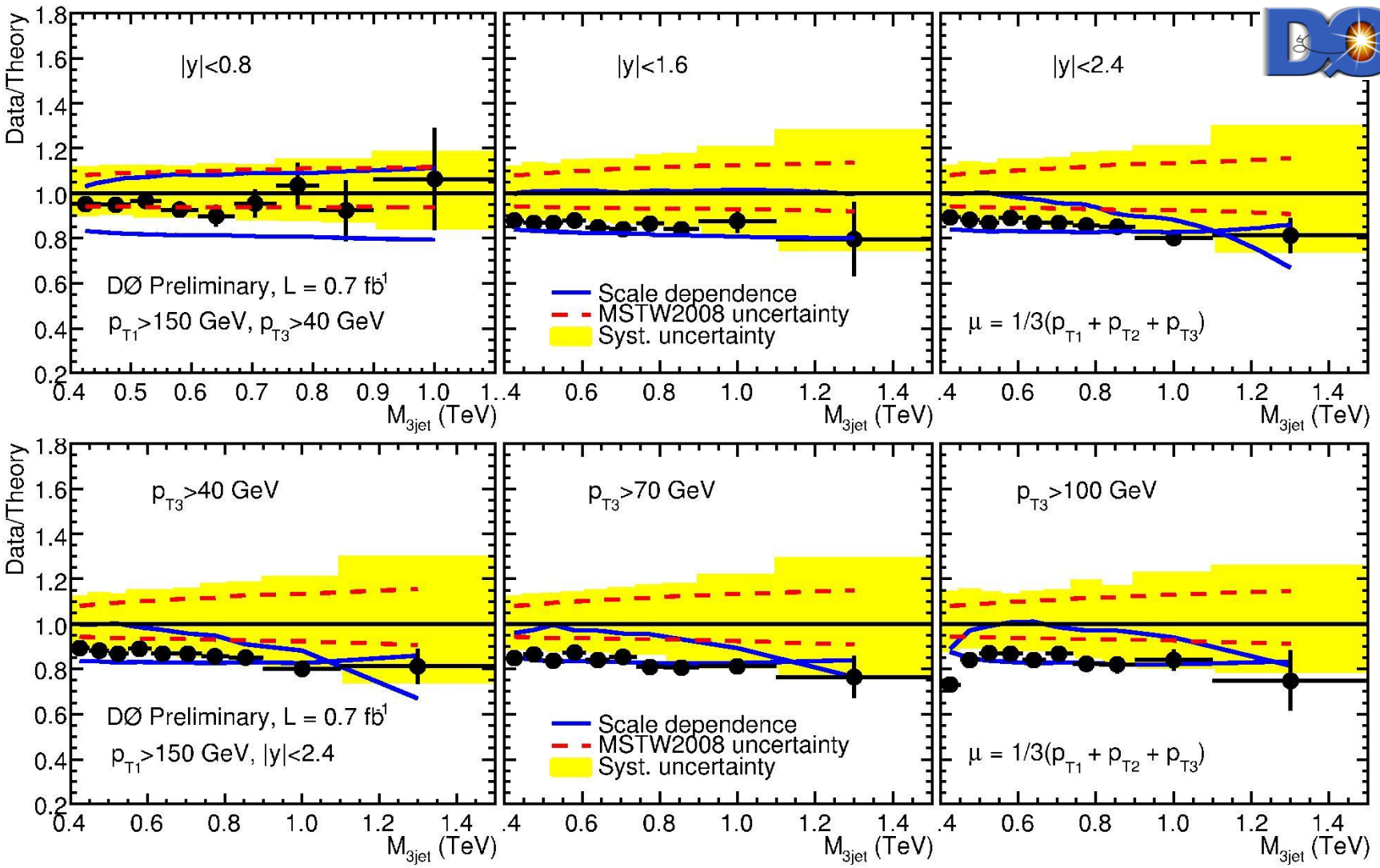
Invariant masses > 1 TeV !

Total systematic uncertainty:
20—30% (dominated by JES, p_T resolution and luminosity)

Tension with NLO predictions in forward region



Three-jet mass



Reasonable agreement seen between data and NLO

More 3-jet variables can be studied in future with this dataset

Ratio of 3 to 2-jet cross-sections

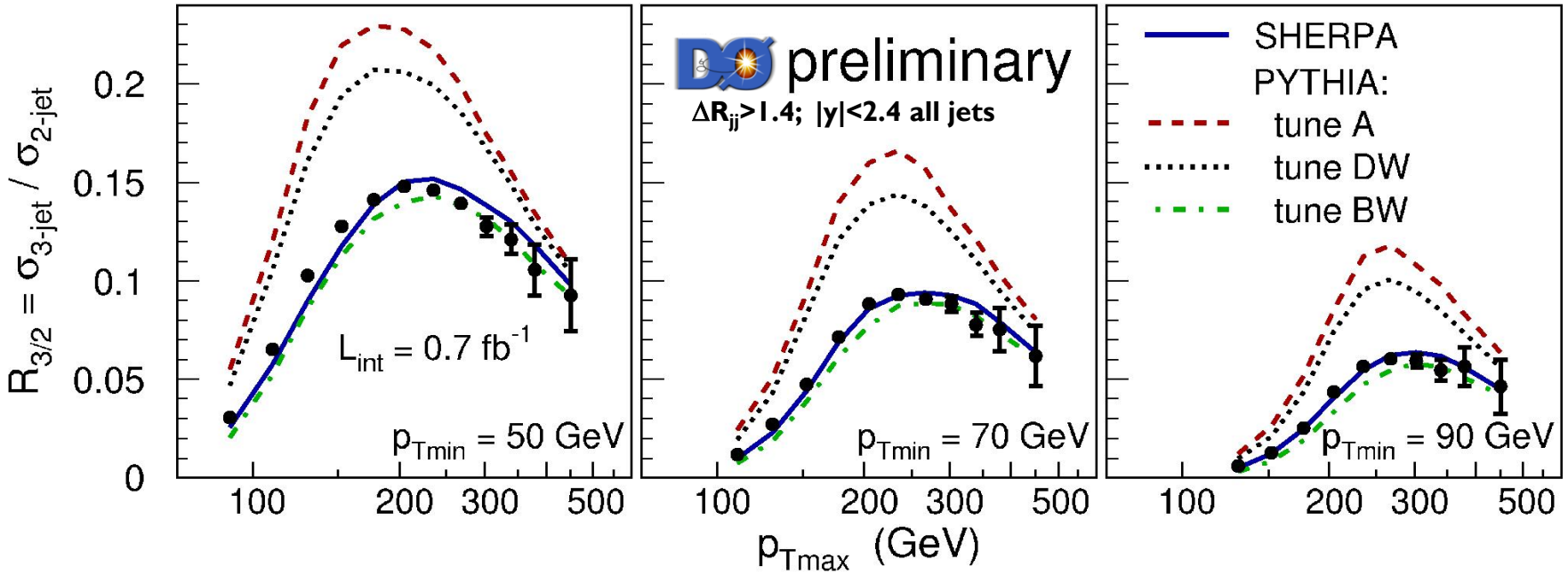
First measurement of ratios of multijet cross-sections at Tevatron

Test of QCD independent of PDFs (small residual dependence because of 2/3-jet subprocess compositions); many uncertainties also cancel in ratio

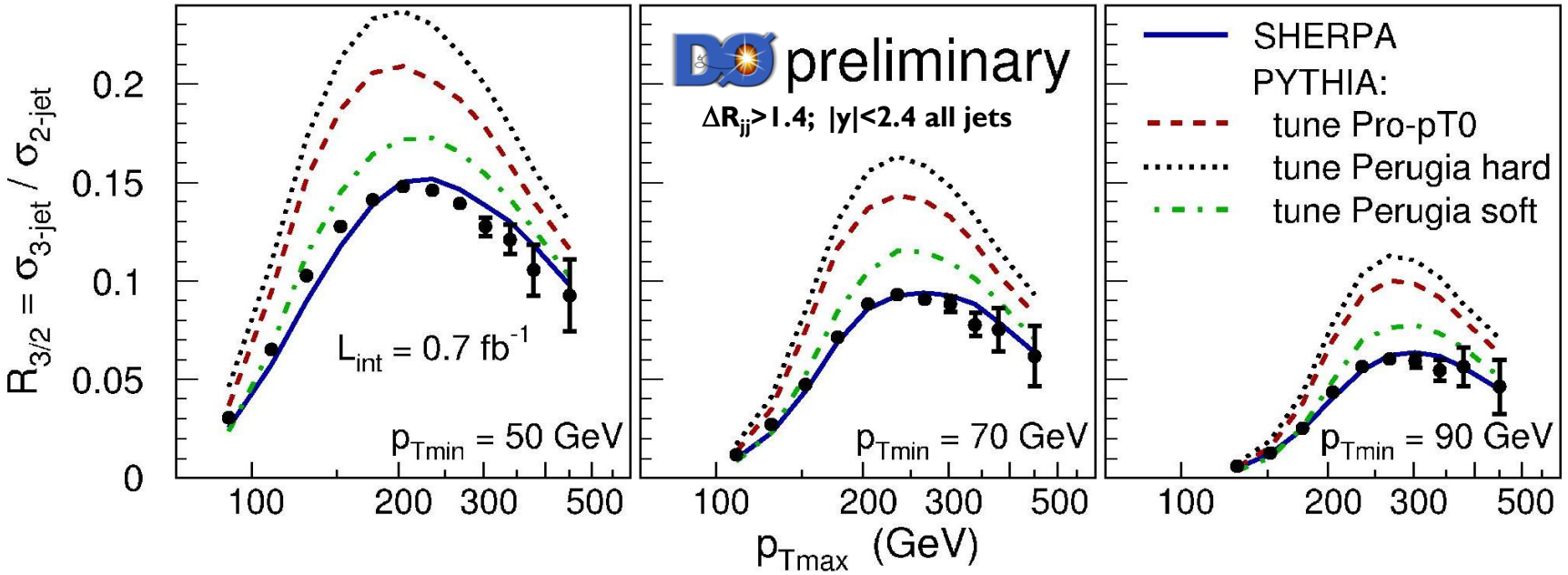
Measure as a function of two momentum $R_{3/2}(p_{Tmax}, p_{Tmin})$= P(3rd jet | 2 jets):

- p_{Tmax} – leading jet p_T (common between 2- and 3-jet)
- p_{Tmin} – scale at which other jets resolved

Probes running of α_s in Tevatron energy regime up to p_T of 500 GeV



Ratio of 3 to 2-jet cross-sections



Excellent agreement to Sherpa 1.1.3 (MSTW2008 LO)

Pythia comparisons (Q^2 and p_T-ordered showers) weighted to describe dijet χ data do not describe data; tension with azimuthal decorrelation results

Experimental corrections small everywhere: (-10%,+20%)

Dominated by systematics below 250—300 GeV

(JES 3—5%, model-dependent corrections 2—6%, p_T-resolution 1.5%)

Future studies: NLO pQCD comparisons; extract α_s (test running)? $R_{4/2}$?

Summary

Have presented the latest jet results from the Tevatron, using highly studied and precisely calibrated data from early RunII period

Inclusive jet cross-sections extended to higher rapidities and transverse momenta up to 600 GeV
Detailed studies of the effect of different jet algorithms tested: important for LHC

Measurements of dijet mass (and searches for new physics)

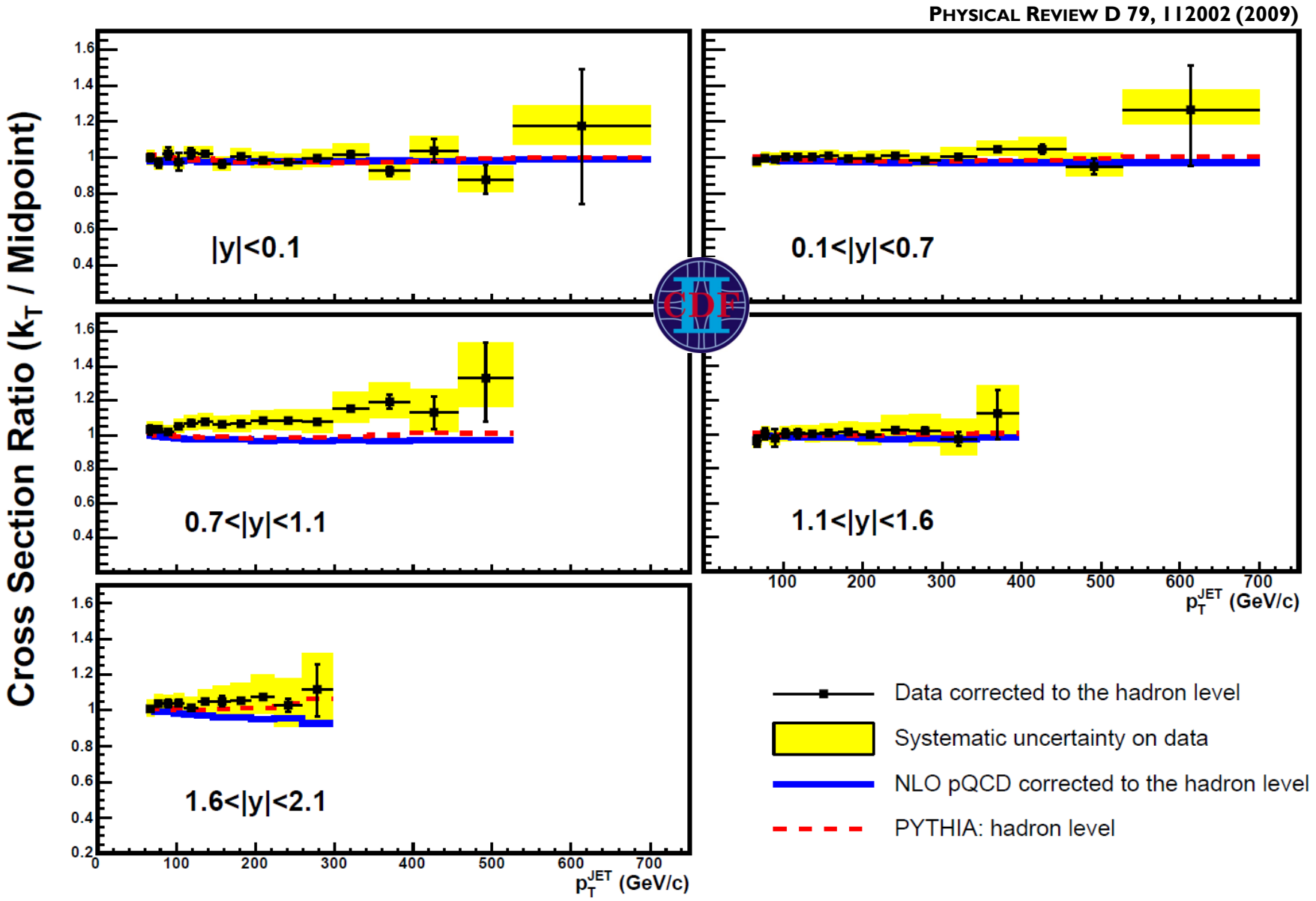
New measurements of three-jet mass and ratio of 3-to-2 jet cross-sections

Good agreement seen with NLO pQCD within uncertainties
Experimental uncertainties now lower than theory uncertainties

Much more integrated luminosity to be exploited by Tevatron for further study

Additional slides

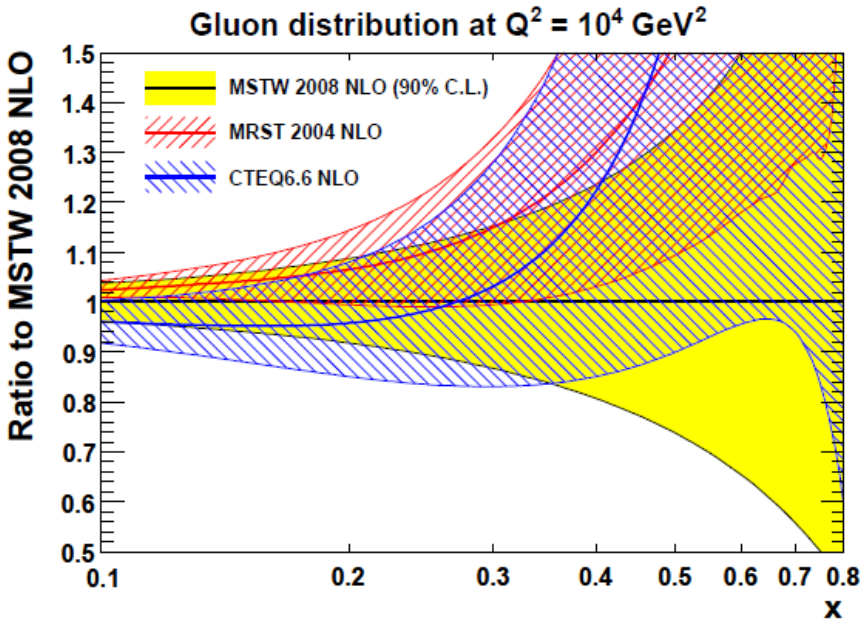
Comparison of Midpoint to k_T (inclusive jets)

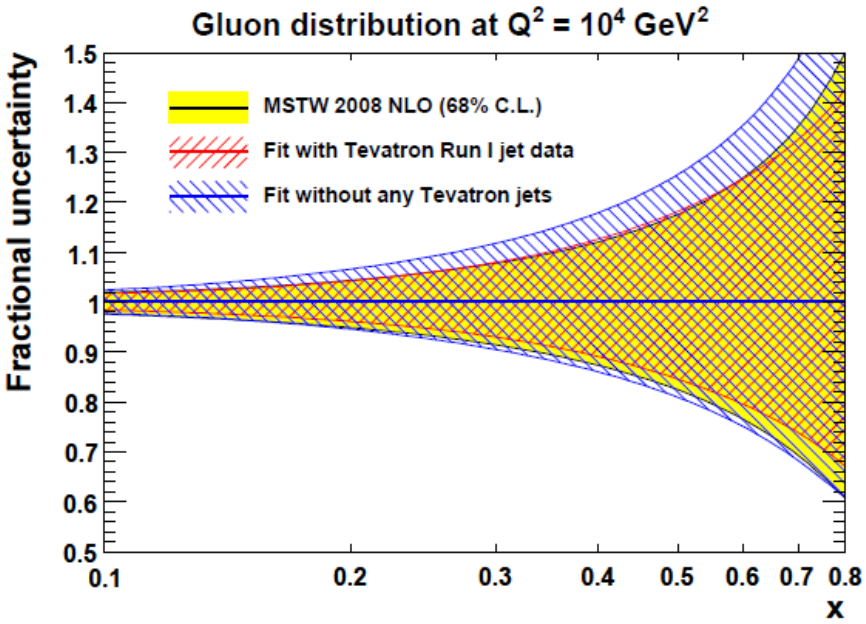


Impact on gluon distribution function

Tevatron plays significant role in determination of gluon PDF at high x from Run I/II jet data

Run II inclusive jet measurements more accurate than Run I, span larger p_T range



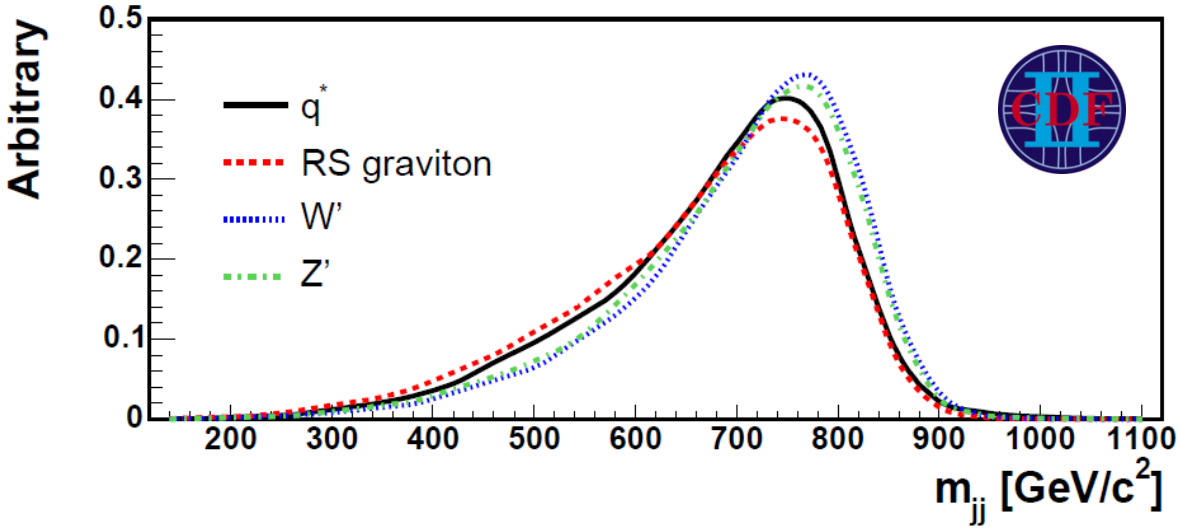


New g(x) lower than previous fits for x>0.3, but within systematic uncertainties

Will impact LHC predictions for gluon-quark dominated scattering processes

Dijet mass searches

All models considered by CDF dijet mass analysis predict width smaller than mass resolution



Expected mass shapes for excited quark, graviton, W' and Z' determined by decay channel (gg, gq, qq) – general shape can be used for resonance search

-- Model detail independent